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Optimal growth of Eady edge waves

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The classical Eady model with zero interior perturbation potential vorticity and a modification with nonzero beta parameter are treated in terms of edge waves, which are propagating on the oppositely directed pseudo-potential vorticity gradients induced by the rigid upper and lower lid. By this reformulation it is made possible to derive easily interpretable equations for optimal instantaneous growth. In the modified model the coupling between the amplitudes of the edge waves is not equal in contrast to the classical model. Nevertheless, it is proven that the optimally instantaneously growing disturbances (OIs) and their growth rates are identical in both models.

The relationship of the OIs to optimally growing disturbances for synoptic time scales (the singular vectors, SVs) and infinite time (the growing normal modes, NMs) is examined. Thereby, the ability of the OIs to maintain their growth rates is infered. This ability depends on the similarity between the NM structures and the OI structures and therefore differs between the two models. The SV growth rates and the SV evolution can be explained with the aid of the previous results, i.e. it is possible to deduce the SV growth rates qualitatively by modulating the OI growth rates with the ability of the SVs to maintain these optimal growth rates. Correspondingly, the SV evolution is determined by the OI and NM structures. The SVs evolve such that they transit exactly through the OI structure toward the growing NM structure or to its remnants in the stable parameter range near to the cutoffs, where a growing NM does not exist. The norm-dependency of the OIs and SVs is examined and on the basis of these results it is possible to classify all norms considered here into two groups with qualitatively different characteristics.

The results suggest that the unequal coupling between the edge wave amplitudes, which is investigated here, might be relevant to rapid surface cyclone development and

Petterssen type B development, in case the vertical windshear decreases with height.